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BIOTECHNOLOGY LABORATORY

PROGRESS REPORT

DECEMBER 15, 1964

UPPER EXTREMITY PROSTHETICS RESEARCH

(Contract V1005p-9779 with U.S. Veterans Administration)

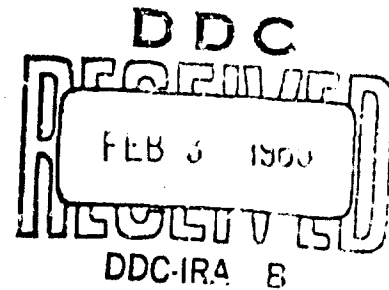
HUMAN TRACKING

(Contract N123 (60550) 32857A with U.S. Naval Ordnance Test Station,
China Lake, Calif.)

SENSORY MOTOR CONTROL

(Grant VRA RD-1201M-64)

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Project Leader: John Lyman
Professor of Engineering and Psychology
Head, Biotechnology Laboratory

Engineering Dept. Report 64-58

DEPARTMENT OF ENGINEERING
University of California
Los Angeles

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Report No. 64-58
June 15, 1964-December 15, 1964

**BIOTECHNOLOGY LABORATORY
PROGRESS REPORT**

**UPPER EXTREMITY PROSTHETICS RESEARCH
(Contract V1005p-9779 with U.S. Veterans Administration)**

**HUMAN TRACKING
(Contract N123(60530) 32857A with U.S. Naval
Ordnance Test Station, China Lake, California)**

**SENSORY MOTOR CONTROL
(Grant VRA RD-1201M-64)**

**Project Leader: John Lyman
Professor of Engineering and Psychology
Head, Biotechnology Laboratory**

**Department of Engineering
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FOREWORD

The research described in this Biotechnology Laboratory Progress Report was carried out under the technical direction of John Lyman and is part of the continuing programs in Upper Extremity Prosthetics Research, Human Tracking, and Sensory-motor Control Research.

The Biotechnology Laboratory is part of the Department of Engineering of the University of California, Los Angeles. L.M.K. Boelter is Dean of the College of Engineering and Phillip F. O'Brien acts as his representative for research activities.

TABLE OF CONTENTS

	<u>Page</u>
UPPER EXTREMITY PROSTHETICS RESEARCH	
1.0 Needs Analysis for Development of Externally-Powered Prostheses Design Specifications.	1
1.1 Objective	1
1.2 Current Status	1
2.0 Analysis of Existing Externally-Powered Prostheses and Development of Advanced Design Specifications	1
2.1 Objective	1
2.2 Current Status of Experimental Investigations of the Heidelberg Pneumatic Arm	2
2.3 Comments	2
2.4 Current Status of Experimental Investigations of the Northwestern Attitudinally Controlled Elbow.	2
2.5 Current Status of Experimental Investigations of the AIPR Pneumatic Arm.	2
RESEARCH ON SENSORY MOTOR CONTROL	
1.0 Objective	4
2.0 Current Status of Experimental Investigations of Functional Muscle Isolation	4
2.1 Experiments	4
2.2 Results	4
3.0 Experimental Investigations of Breathing Control for Performance Facilitation of Abdominal and Pectoralis Control Sites.	5
3.1 Objective	5
3.2 Experiment I	7
3.3 Experiment II	7
3.4 Experiment III	8
3.5 Experiment IV	8
3.6 Experiment V	9
3.7 Experiment VI	9
3.8 Future Plans.	11

TABLE OF CONTENTS (Cont.)

	<u>Page</u>
4.0 Performance Evaluation of the Belgrade (Yugoslavia) Electronic Hand.	11
4.1 Project Description and Objectives	12
4.2 Current Status	14
5.0 Project Publications	14
5.1 Conclusions of the Preliminary Report	14
III. RESEARCH ON THE PERFORMANCE OF HUMAN OPERATORS OF TRACKING SYSTEMS	
1.0 Performance Evaluation of Variables of the Optical System on the NOTS Tracking Simulator	15
1.1 Objective	15
1.2 Experimental Investigations on the NOTS-UCLA Tracking Simulator	15
2.0 Project Publications	20
IV. PROFESSIONAL ACTIVITIES OF STAFF MEMBERS	20
V. VISITORS TO THE LABORATORY	23

I. UPPER EXTREMITY PROSTHETICS RESEARCH

Sponsor: U.S. Veterans Administration

1.0 Needs Analysis for Development of Externally-Powered Prostheses Design Specifications

1.1 Objective

1.1.1 To re-evaluate currently used design specifications of existing conventional prosthesis subsystems as, for example, terminal devices, and elbow lift and lock mechanisms.

1.1.2 To compare these design specifications with available criteria for externally-powered prosthesis subsystems, and the specific design goals in terms of functional regain.

1.1.3 To integrate the findings of the needs analysis into design criteria quantification of the complete externally-powered prosthetic system.

1.2 Current Status

Phase 1 has been brought to conclusion after completion of the survey on terminal devices. A manuscript has been submitted to the project leaders for revision. Careful assessment of the practical value of this study for guiding future terminal device design directions will be made. The outcome will determine the direction and suggest fruitful methodologies for conducting similar analyses for other prosthetic subsystems.

2.0 Analysis of Existing Externally-Powered Prostheses and Development of Advanced Design Specifications

2.1 Objective

To make an engineering and performance evaluation of existing devices to assess their capabilities and limitations and derive specifications for further development.

2.2 Current Status of Experimental Investigations of the Heidelberg Pneumatic Arm

A first draft of a technical report summarizing the performance evaluation of the Heidelberg Pneumatic Prosthesis has been completed and submitted for editing. The report presents descriptive engineering data regarding the gross performance aspects of the prosthesis, description of its components and results of performance tests with amputee subjects.

The performance study indicated that the Heidelberg Prosthesis can be operated usefully in most situations in which a conventional prosthesis is used. However, in general, performance with it was less accurate, slower, and involved considerably more errors. The prosthesis required more maintenance than the conventional prosthesis used for comparison. Active wrist rotation of the Heidelberg prosthesis did not substantially improve performance due to difficulty of control and variability of its action.

2.3 Comments

Upon completion of editing of the first draft, a final draft of the technical report will be made and submitted for publication. This will conclude the laboratory evaluation of this prosthesis.

2.4 Current Status of Experimental Investigations of the Northwestern Attitudinally Controlled Elbow

Continuous technical difficulties delayed progress of the engineering analysis throughout the third quarter of 1964. The problems were primarily in the mercury switch system, and have been largely resolved.

During the fourth quarter, analysis of subject performance data was undertaken, and is approximately half completed.

2.5 Current Status of Experimental Investigations of the AIPR Pneumatic Arm

The custom-made pneumatic arm developed by Dr. Kiessling of the American Institute for Prosthetic Research has been fitted to one

subject, a right unilateral A/E amputee. All fitting was done by Carl Sumida of the Child Amputee Prosthetics Project at UCLA according to specifications from Dr. Kiessling.

This prosthesis features the following six externally-powered movements: forearm flexion and extension, wrist pronation and supination, and hook opening and closing. All motions are positive, gas-powered (CO₂) movements, controlled by one of two sequential valves.

Elbow and wrist functions are controlled by one valve which is activated by the amputee through a cable attachment to his rear harness support. The sequence of valve positions are as follows:

0. rest
1. forearm flexion
2. forearm extension
3. pronation
4. supination

Terminal device movements are controlled by a separate valve activated by cable attachment to a chest strap. The valve positions are the following:

0. rest
1. closing
2. opening

Training with the prosthesis was begun during the summer and completed in early October. Twenty training sessions of about two hours duration each were completed, ranging from simple intensive drills on each function to more complex and coordinated activities. At the end of training the amputee was able to initiate all movements easily, regulate speed of movement in some cases, and combine two prosthetic motions by simultaneous or overlapping operation of both valves.

Performance and engineering tests are in progress and are approximately 50% complete.

Instrumentation to monitor wrist, elbow and hook movements has been completed and is presently being used in testing precision of motion. Additional instrumentation is being developed for use in analyzing reaction times of subject and prosthetic components in initiation of prosthetic movement. Data acquisition has been aided by temporary loan of a four-channel Sanborn recorder.

II. RESEARCH ON SENSORY MOTOR CONTROL

Sponsor: Office of Vocational Rehabilitation
(Federal Rehabilitation Administration)

1.0 Objective

To conduct basic and applied research on arm prostheses sensory-motor control problems and to undertake analysis of prosthesis-amputee systems.

2.0 Current Status of Experimental Investigations of Functional Muscle Isolation

2.1 Experiments

Studies on functional isolation as outlined in Biotechnology Laboratory progress report (June 15, 1964) were completed. Performance of one subject using two abdominal sites monitored by a pressure sensitive carbon transducer system was studied in the following series of control tasks:

- (a) Discrete contraction of abdominal sites individually in rapid alternation, at ten different combinations of contraction rate and alternation-between-site rate.
- (b) Discrete, graded contraction of a single site for a fixed time period.
- (c) Continuous, graded contraction of a single site.
- (d) Continuous, graded contraction of two sites.

2.2 Results

Performance on the first three tasks was good; however, tasks one and three required additional training before a performance plateau was reached. Performance data for the fourth task are presented in

Figure 1. This task was conducted for eight training sessions. The subject had a large amount of training since he also performed the first three tasks. The specific task was "pursuit tracking" in which the subject controlled the vertical and horizontal positions of a dot on the face of an oscilloscope by transducers at both abdominal sites. The tracking function was represented by a second dot across the oscilloscope face in a linear path (9 cm) at 45° . The three input frequencies were: .05; .10; .20, cps.

Tracking scores, measured in terms of average integrated radial error taken over 30 seconds tracking intervals, can be assessed by comparison to a calibration error score of 35 volts which corresponds to a constant tracking error of 1 cm. over the tracking interval.

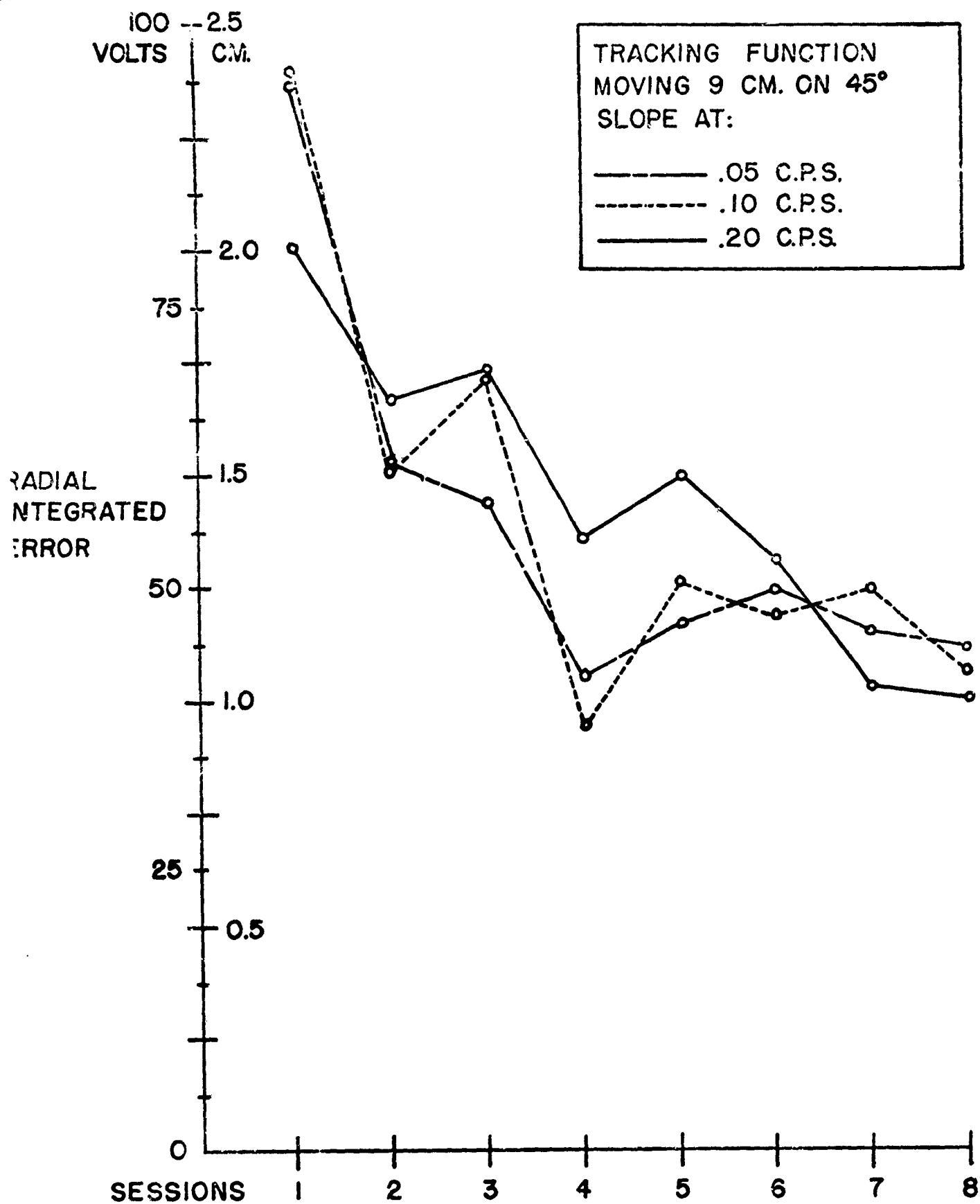
Engineering data on the operating characteristics of the pressure sensitive carbon transducers were taken after subject performance testing was completed. These data include:

- (a) Change in output voltage with change in environmental temperature.
- (b) Drift in output voltage over long term dynamic operating conditions.
- (c) Drift in output voltage under conditions of static loading.
- (d) Hysteresis -- output voltage as a function of applied pressure during loading and unloading of the transducer.

3.0 Experimental Investigations of Breathing Control for Performance Facilitation of Abdominal and Pectoralis Control Sites

3.1 Objectives

Importance of breathing control in training and performing abdominal and pectoralis tracking. Combination and isolation of breathing, abdominal and pectoralis contraction.



SENSORY MOTOR CONTROL UTILIZING ABDOMINAL SITES
TWO-DIMENSIONAL TRACKING VARYING STIMULUS FREQUENCY

FIGURE 1

3.2 Experiment I

3.2.1 Equipment: Photo-cell transducer on the abdomen, respiratory belt, EMG record, photo-cell or strain-gauge transducer on pectoralis.

3.2.2 Method: The subject is asked to follow a line on the oscilloscope moving at different frequencies; .01; .05; .1; .5; 1.0; 1.5; either with the abdominal or with the pectoralis transducer. The duration of the performance is 30 seconds; the rest interval is 30 seconds.

3.2.3 Results: Breathing control is the first step to abdominal or pectoralis-controlled contraction; the breathing frequency is related to the tracking frequency; the highest correlation is found for .5 cps. With training, the subject is able to achieve some independence and continue to breathe normally while tracking either very slowly or at high speeds. Chest expansion precedes both abdominal and pectoralis contraction; at .05 cps the performance is better when the subject holds his breath; for the abdomen as well as for the pectoralis up-tracking is superior to down-tracking for two reasons: loss of breathing control and lack of sensory feedback.

3.3 Experiment II

3.3.1 Equipment: Photo-cell transducer on abdomen; respiratory belt, EMG record.

3.3.2 Method: The subject is asked to track with his abdominal muscles, as long as possible, three frequencies: .05; .5; 1.0 cps.

3.3.3 Results: For 0.5 cps the task can be continued for long periods without fatigue or breathing difficulties. An input frequency of .5 cps is slightly higher than the normal resting breathing frequency for different subjects. For an input frequency of 1.0 cps, performance can continue for prolonged periods but hyperventilation and dizziness may occur. Relaxation time for the abdominal muscles is too short and fatigue appears after 20 minutes. For an input frequency of .05 cps the task has to be stopped after about 10 minutes; the subject gets "out of breath" and tends to relax the abdominal muscles too early. Fatigue and pain in the abdominal muscle also occur.

3.4 Experiment III

3.4.1 Equipment: The same as in Experiment II.

3.4.2 Method: The subject is asked to perform rhythmical activity at different rates with the abdominal transducer and the respiratory belt. There is no visual feedback from the oscilloscope.

3.4.3 Results: The subject is able to dissociate breathing and abdominal contraction in the following ways:

- (a) slow tracking and regular breathing at different rates (the best being around .5 cps for the forcing function input)
- (b) regular breathing at a certain rate being used as an internal feedback to contract his abdominal muscle at different rhythms (1:1; 1:2; 1:3 etc., breathing rate to contraction rate)
- (c) like Condition (b) with contractions of different rhythms and different duration (1:3; with abdominal contraction lasting for two breathing cycles, etc.)
- (d) like Condition (b) with different amplitudes of contraction. Without better sensory feedback from the transducer, the subject is able to discriminate among four different amplitudes. Using breathing control as a rhythmical feedback he can increase or decrease the contraction amplitude or change from one specified amplitude to another.

3.5 Experiment IV

3.5.1 Equipment: Same as in Experiment II.

3.5.2 Method: The subject is asked to track for one minute with visual feedback watching the oscilloscope and afterwards without visual feedback and to repeat the experiment without feedback after a rest interval of several minutes. Three input frequencies were used: .05; .5; 1.0 cps.

3.5.3 Results: With both .5 and 1.0 cps the memorization of frequency and amplitude was good. A certain tendency to slow down and get closer to the normal rest breathing frequency was especially marked for .5 cps. For .05 cps input frequency, memorization is initially more degraded in time than in amplitude. It deteriorated rapidly for both time and amplitude.

3.5.4 Remarks: Controlled pectoralis contraction without visual feedback is less accurate for reproducing amplitude or rate than controlled abdominal contraction without feedback.

3.6 Experiment V

3.6.1 Equipment: Photo-cell transducer on the abdomen respiratory belt.

3.6.2 Method: The goal was to determine the effect of heavy physical exercise on abdominal tracking. The subject first lifts a heavy weight several times and then tracks at different speeds. After lifting, the breathing frequency is higher.

3.6.3 Results: Lifting influenced tracking in two ways: the subject got tired rapidly and seemed to lose his abdominal control. The input rate of .5 cps is considered too slow, which may be related to the breathing frequency.

3.7 Experiment VI

Isolation and coordination of abdominal and pectoralis transducers were first performed with a photo-cell transducer on the pectoralis. As this transducer was fixed around the chest, voluntary or involuntary chest expansion produced pectoralis responses. Further difficulties arose because of anatomical differences between subjects. Therefore, the experiment was continued with a strain gauge transducer glued to the pectoralis muscle.

Detailed results on this experiment will be reported in the next progress report.

The general results are: Isolation of both sites are easily performed by trained subjects especially if the abdominal transducer is fixed on the lower part of the abdomen. Some involuntary responses may be induced if the amplitude of the voluntary response is very large. In this case, the chest expansion can produce a response either in the abdominal or in the pectoralis transducer.

The subjects succeeded in performing the following tasks:

- 1) Slow coordinated contraction of both sites (the performance is usually better for the transducer with visual feedback but the subject can be trained to give a progressive response without visual feedback).
- 2) Delayed response from one or the other transducer while one site continues the tracking tests.
- 3) During up-tracking with one transducer, maintaining also a certain degree of response in the other.
- 4) Tracking up with both transducers, and half way dropping one or the other transducer response.
- 5) Performing different rhythms with one or the other transducer; for example: pectoralis up and down at .5 cps, abdominal response every other time, or, abdominal up and down at .4 cps, pectoralis up and held during two abdominal responses and so on.

Holding the same level of response is easier to perform with the abdominal transducer than with the pectoralis transducer. The abdominal response is a gross response while the pectoralis response is more closely associated with the contraction of the pectoralis. Association of different rhythms with different amplitudes of response is also possible with and without visual feedback. Abdominal response without feedback is easier to accomplish than pectoralis response. For these tasks and without the trained subject being conscious of his breathing rate, we get three different outputs each with a particular shape; the abdominal transducer response, the pectoralis transducer response and the respiratory belt response.

As was pointed out before, rhythmical activities are easier to perform than slow and continuous contractions for two reasons: 1) breathing control and 2) muscle relaxation characteristics. As far as slow continuous tracking is concerned, the performance is generally better for up than down-tracking even though the subject may find the down-tracking task easier.

For performing these tasks, mental concentration and instructions from the experimenter were found to be very important.

3.8 Future Plans

Development of training programs

Isolation and coordination of new sites

Two-dimensional tracking (with a new device)

Measurement of muscular fatigue by EMG records

Improvement of transducers and harnessing

Comparison of muscular effort as function of transducer type

4.0 Performance Evaluation of the Belgrade (Yugoslavia) Electronic Hand

A functional evaluation of the two laboratory prototypes Belgrade electronic hand was conducted as part of the continuing research and development project in Belgrade, Yugoslavia, under the medical direction of Dr. Bosko Zotovic and the technical direction of Dr. Rajko Tomovic.

The project is supported by the Secretary of Health and Social Policy, Executive Council and the Federal Rehabilitation Institute in Belgrade, Yugoslavia.

Dr. Groth's participation was jointly sponsored by the following agencies:

- 1) U.S. State Department Travel grant
- 2) Grant VRA RD-1201M-64, Sensory Motor Control,
Office of Vocational Rehabilitation, HEW
- 3) Federal Rehabilitation Institute, Belgrade, Yugoslavia

The experimental research has been conducted at Zavod za ortopedsku protetiku SR Srbije from June 1, 1964 to September 1, 1964. Data reduction and analysis will be carried out by the investigators during the remaining months of the year while they resume their normal activity. A complete technical report will be published and distributed after completion of the data analysis.

4.1 Project Description and Objectives

For the past four years, Dr. Rajko Tomovic and his collaborators have directed efforts toward constructing a laboratory prototype of an externally-powered artificial hand. This development represents the first attempt to apply automatic control theory to the design of an artificial hand. Its primary aim was to relieve the amputee of some of the decisions necessary for voluntary guidance of selected prosthetic control motions.

Reduction of the number of decisions and simultaneous reduction in the number of body control sites required for each prosthetic movement represents one important design criterion for advanced prosthetic systems for the severely handicapped. Since the rehabilitational value of any arm prosthesis is determined largely by the degree of accuracy and reliability with which the amputee can guide the prosthetic movements, patients with high level amputations or bilateral amputations lack the necessary number of functionally independent body control sites for replacement of the lost functions. The conventional approach for such patients has been the use of sequential controls activated by a single body site. Such an arrangement places a great burden on the amputee, since he must remain constantly aware of the present control position as well as of the location of the correct position for executing any subsequent desired motion.

The electronic hand provides a "memory" for two prehension patterns and an "external control loop" for pattern selection. If two rows of pressure sensitive elements are placed on the artificial fingers, external contact with either row will determine the prehension pattern after motor activation.

These patterns are tip prehension for fine manipulation and palmar prehension for grasping large and bulky objects.

Additional important functional characteristics of the hand can be summarized as follows:

- 1) Use of articulated fingers that will conform to the shape of a grasped object in a manner similar to that of the normal human hand
- 2) Proportional voluntary control over grasping speed and prehension force

For the first prototype, no attempt has been made to couple hand functions with other prosthetic functions as, for example, wrist rotation or elbow flexion. Although the project staff recognizes that the final utility of the prosthesis must depend on the successful coordination of all control movements, at the present level of development it was necessary to evaluate the isolated hand functions and avoid confounding of the results with additional complex interactive problems.

For this reason, it was decided to conduct the first evaluation on below elbow amputees only, since no other functional replacements were required for them. We were well aware that this group of patients has relatively little need for such a technologically advanced prosthesis for adequate rehabilitation.

The primary aims of the evaluation project can be summarized as follows:

- 1) To obtain quantitative engineering design specifications based on amputee performance for construction of a limited number of manufacturer's models of the hand.
- 2) To identify and specify the medical-psychological interactions with the control and performance characteristics of the hand.

4.2 Current Status

Data reduction is in progress both in Belgrade and at UCLA.

5.0 Project Publications

Arezina, Petar, M.D.,[†] and Groth, Hilde, Ph.D.[‡] "Preliminary Report of the Clinical Evaluation of the Belgrade Electronic Hand", UCLA Department of Engineering, Report No. 64-47, September, 1964.

[†] Zavod za ortopedsku protetiku SR Srbije, Belgrade, Yugoslavia

[‡] University of California, Los Angeles, U.S.A.

5.1 Conclusions of the Preliminary Report

In order to achieve a functional improvement of the manufacturer's model of the electronic hand, the following research and development problems should be undertaken simultaneously:

- 1) To make mechanical modifications that will provide better finger joint stability, an increase in prehension force, a lighter prosthesis and reduction in bulkiness.
- 2) To make the following electronic changes: provision of a three-position switch for grasp control, a change in the transducer output characteristics to match the human sensory-motor capabilities in muscle contraction, elimination of the motor reversal switch.
- 3) To initiate studies for selection and development of body control sites by training and/or surgical methods to provide the necessary reliable input for the new transducers.
- 4) To develop methods for long duration transducer attachment, taking into account problems of comfort, toxicity, ease of attachment and criticality of location.

III. RESEARCH ON THE PERFORMANCE OF HUMAN OPERATORS OF TRACKING SYSTEMS

Project Administered by U.S. NOTS
China Lake, California

Sponsors: U.S. Naval Ordnance Test Station, China Lake, California
Pacific Missile Range, Point Mugu, California
Department of the Army, White Sands Missile Range, New Mexico
Electronic Systems Division, Air Force Systems Command,
L. G. Hanscomb Field, Bedford, Massachusetts

1.0 Performance Evaluation of Variables of the Optical System on the NOTS Tracking Simulator

1.1 Objective

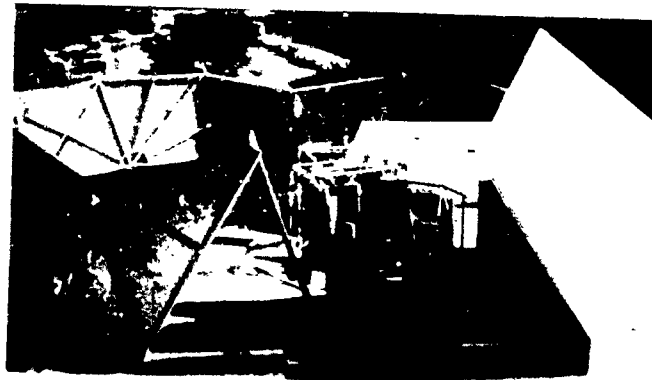
Systematic evaluation of variables of the optical system on target acquisition and tracking accuracy. Design specifications for optimum performance shall be derived. Handbooks or tables will be ultimately developed to aid tracking system designers.

1.2 Experimental Investigations on the NOTS-UCLA Tracking Simulator

1.2.1 Relocation of tracking laboratory: The building containing the tracking laboratory was destroyed in order to make way for a university parking project. Relocation of the simulator has been accomplished and construction of the new building has been essentially completed.

Installation of the tracking quarters here, electrical wiring system and associated apparatus should be completed during the month of December. It is expected that experimentation may be resumed early in 1965. Figure 2 shows the various stages of construction over several months.

1.2.2 Target generating device: A method of generating trajectories for the Human Tracking Project was devised so that position, velocity and acceleration in azimuth and elevation could each be electrically programmed. This method is a replacement for the current cam-controlled method in which position is varied with time, and velocity and acceleration are incidental by-products. It is expected that the system will be in operation by early 1965.



**STAGES OF CONSTRUCTION IN RELOCATION OF NOTS-UCLA
TRACKING SIMULATOR**

FIGURE 2

Basically the electrical method controls velocity directly as a function of voltage to two small d-c motors, one each in the azimuth and elevation axes. The motors rotate at 11,000 RPM at a nominal voltage of 28 volts d-c. A gear box with a reduction of approximately 600X is provided with each motor. The gear boxes are currently being modified to give a reduction of approximately 3600X, corresponding to velocities from 1 through 20 degrees/second with a voltage variation range of 4 through 28 volts d-c. The voltage for the motors will be obtained from potentiometers rotated by a third motor.

1.2.3 Tape data program: A program for reducing the analog tapes produced by the Sampled Error Scoring System (SESS) described in previous reports was completed. Analog pulses of azimuth and elevation error and position as well as reference data are recorded 24 times/second during a test and these records are converted to digital form by NODAC at NOTS. This conversion is necessary to make the tapes suitable for use as inputs to the IBM 7090/7094 Fortran II programs.

The program analyzes these digital tapes and produces output in the form of zoned time-on-target scores and real time printouts and graphs. Time-on-target scores are tabulated in seven successive .5 degrees of error zones. For instance, each sampling period during which the error is between 0 and .5 degrees contributes one count to the first error zone while all errors greater than three degrees contribute counts to the seventh zone -- "over three degrees". The program further subdivides the error zones into quadrants. A second time-on-target table tabulates the number of times the azimuth and elevation errors occur in the same zone.

In addition to the time-on-target information, the program calculates lists of 21 variables and gives output in the form of tabulated results or graphs. The variables are the mount and trajectory position, velocity and acceleration in each of the azimuth, elevation and resultant dimensions, and the error in each of these dimensions. For the graphs

the additional variables of "sampling point number" and "elapsed time" are available. Any two of these variables may be plotted against each other.

The program allows the experimenter to process only certain data runs on the input tape. The tape may be rewound and a second pass run with different output requests.

The data available from the SESS will provide more complete and permanent error information than is currently available with the IESS (Integrated Error Scoring System) as well as allowing detailed studies of such factors as human sampling rates and reaction times.

1.2.4 Comment: A complete description of the program's capabilities as well as its structure has been prepared as a Biotechnology Report and is currently being distributed.

1.2.5 Experimental plans: Work is planned for the first of a two-part experiment relating to problems of initial target acquisition and reacquisition. The following tentative design has been developed:

Phase I: Initial acquisition

In this phase the simulator and optical system are oriented in the center of the quartersphere (90° azimuth, 0° elevation). The operator's task is to intercept the target as quickly as possible under the following conditions:

1. Acquisition aiding:
 - a. wide angle lens
 - b. wide angle lens plus acquisition aid display*
(simulator orientation only)
 - c. wide angle lens plus acquisition aid display
(target orientation only)
 - d. wide angle lens plus acquisition aid display
(target plus simulator orientation)

*The acquisition aid display was discussed in some length in the March, 1963 progress report.

2. Target starting position:
 - a. 0° azimuth, 0° elevation at the quartersphere
 - b. 45° azimuth, 30° elevation at the quartersphere
 - c. 90° azimuth, 60° elevation at the quartersphere
3. Type of trajectory:
 - a. predictable - known to operator
 - b. unpredictable - unknown to operator

Phase II: Reacquisition

In this phase the apparatus is so arranged that the operator loses the target at a prescribed time. His task is to intercept the target under the following conditions:

1. Type of target loss:
 - a. simulated cloud-normal ballistic trajectory
 - b. radical change in trajectory
2. Acquisition aiding:
 - a. switching between two fields of view
 - b. switching between two magnifications
 - c. superimposing two magnifications
 - d. acquisition aid display (simulator orientation only)
 - e. acquisition aid display (simulator plus target orientation)
 - f. acquisition aid display (simulator plus target orientation -- target information slightly delayed)
 - g. no aiding
3. Type of trajectory:
 - a. predictable - known to operator
 - b. unpredictable - unknown to operator

The experiment is designed primarily for gathering information on two important aspects of the tracking task:

- 1) To determine the capabilities and limitations of human predictive processes in tracking;

2) To assess the utility of various modes of target acquisition. It is hoped that such information will aid in the development of optimum visual displays regardless of the nature of target trajectories encountered.

2.0 Project Publications

Sokolow, Stanley, Garfinkle, David R., Groth, Hilde, and Lyman, John, "NOTS-UCLA Tracking Installation Analog Tape Description and Reducing Program", UCLA Department of Engineering, Report No. 64-54, November, 1964.

(Abstract: The analog tape data recorded by the Sampled Error Scoring System is described; a program for reducing the data by means of the IBM 7090/7094 computer system is also described. Output data may be in the form of time-on-target charts and graphs or lists of pertinent variables. A sample execution and the Fortran II program are included as appendices.)

IV. PROFESSIONAL ACTIVITIES OF STAFF MEMBERS

June 1 to September 4, 1964:

Dr. Groth conducted the performance evaluation of the Belgrade electronic hand at the Rehabilitation Institute of the Republic of Serbia, Belgrade, Yugoslavia.

June 15, 1964:

Dr. Lyman was elected president of the Los Angeles Chapter of the Human Factors Society.

June 23-26, 1964:

Dr. Lyman attended the meeting of the subcommittee on Design and Development of the Committee on Prosthetics Research and Development of the National Academy of Sciences - National Research Council in New York City.

July 3-7, 1964:

Dr. Groth Visited the Rehabilitation Centers and attended staff conferences in Athens, Greece.

July 25, 1964:

Dr. Lyman spoke at a symposium conducted by four western chapters of the Human Factors Society at Santa Barbara, California. His subject was "The Future of Human Factors from the Academic Viewpoint".

August 2-8, 1964:

Dr. Groth attended the XV International Congress of Applied Psychology in Ljubljana, Yugoslavia.

August 9, 10, 1964:

Dr. Groth presented two seminars to the staff of the Rehabilitation Center in Ljubljana, Yugoslavia on "Evaluation Methodology and Practical Problems in Assessing Prosthetic Devices".

August 12, 13, 1964:

Dr. Groth presented two seminars to the staff of the Rehabilitation Institute in Zagreb, Yugoslavia, on "Evaluation of the Belgrade Electronic Hand and Other Externally-Powered Prosthetic Devices".

August 29-31, 1964:

Dr. Groth presented the preliminary results of her summer research to members of the staff of the Rehabilitation Institute in Belgrade and selected staff of the Institute Mihajlo Pupin.

September 3, 1964:

Dr. Lyman presented an invited talk, "Transducers for Non-manual Control", at a research seminar at the Delft Technical University, Delft, Netherlands.

September 15, 16, 1964:

Dr. Groth visited the Institute of Industrial Science of the University of Tokyo and the National Rehabilitation Institute in Tokyo, Japan, and reported on the research in Belgrade.

September 23-26, 1964:

Dr. Lyman attended the International Ergonomic Congress at Dortmund, West Germany, and presented a paper, "Myoelectric and Mechanical Outputs of Isolated Muscles for Skilled Control Applications".

October 3, 1964:

Dr. Lyman attended a meeting of the Committee on Prosthetic Research and Development (NAS-NRC) to plan an International Control Problem Conference.

October 9, 10, 1964:

Dr. Lyman attended a planning and decision-making meeting of the Committee for Biomedical-Engineering Training for the National Institutes of Health in Bethesda, Maryland.

October 18-22, 1964:

Drs. Lyman, Groth and Weltman attended the annual meeting of the Human Factors Society in Washington, D.C.

Dr. Groth presented a paper "Some Theoretical Implications of Cultural Differences for Human Factors Applications".

Dr. Weltman chaired a symposium on "Human Factors and the Developing Nations".

October 20, 1964:

Dr. Lyman and Dr. Groth visited the Harry Diamond Laboratory in Washington, D.C., and conferred about control problems in externally-powered prostheses.

October 22, 23, 1964:

Dr. Lyman and Dr. Groth visited Wright-Patterson Air Force Base in Dayton, Ohio, for contract discussions.

October 23, 1964:

Dr. Weltman visited the submarine base at New London, Connecticut, to confer with experts there about the initiation of related research in the Biotechnology Laboratory.

November 9, 1964:

Dr. Weltman gave a talk for a special University Extension Course on "The Engineer in the Contemporary World". His subject was "The Impact of Technology on Human Values".

November 23, 24, 1964:

Dr. Lyman attended a meeting of the Committee on Prosthetics Research and Development (NAS-NRC) in Chicago to plan the Spring, 1965, Prosthesis and Orthosis Controls Conference.

December 2, 1964:

Dr. Lyman delivered a speech before a meeting of the American Institute of Industrial Engineers, held at Ontario, California. His subject was "Some Recent Biotechnical Researches in Education and Design Methodology".

V. VISITORS TO THE LABORATORY

August 3, 1964:

Harry Blum, Air Force Cambridge Research Labs, (CRBG),
Bedford, Massachusetts.

August 31, 1964:

Dr. Roy Smith, Professor, University of California at
Riverside, California.

Dr. Roger Mills, Director, Sunkist Corporation.

September 17, 1964:

Dr. Warden Waring, Project Director, Attending Staff
Association, Rancho Los Amigos Hospital, Downey,
California.

Jim Allen, Research Engineer, Attending Staff Association,
Rancho Los Amigos Hospital, Downey, California.

Andrew Karchak, Jr., Research Engineer, Attending
Staff Association, Rancho Los Amigos Hospital,
Downey, California.

September 23, 1964:

Ray M. Hoover, M.D., Woodrow Wilson Rehabilitation Center,
Fishersville, Virginia.

James L. Shearin, Woodrow Wilson Rehabilitation Center,
Fishersville, Virginia.

Richard H. Blackmer, General Electric, Schenectady, New York

C. H. McMillan, General Electric, Los Angeles, California.

J. Harvill, General Electric, Los Angeles, California.

December 7, 1964:

H. Firoliz Foulizat, M.D., Orthopedics, University-Klinik,
Münster, Germany.

Hedwig Nidelmann, Orthopedic Technician, Orthopedics,
University-Klinik, Münster, Germany.